The precipitation for the month was greatest and generally above normal in the southwestern part of the district, over an area embracing western Kentucky, western Tennessee, and the extreme northern portion of Alabama. Over this area the amount was generally from 4 to 6 inches, while at a few places in southwestern Tennessee it was from 7 to 9 inches. In the extreme southern portion of West Virginia there was a small area over which 6 to 9 inches occurred. Over the extreme western portion of Pennsylvania, considerable of Ohio, in north-central Indiana, and the upper Wabash basin of Indiana and Illinois the amounts were less than 3 inches. Over the remainder of the district the amounts ranged between 3 and 5 inches.

MISCELLANEOUS.

A local storm with decided tornadic characteristics swept over the eastern portion of Youngstown, Ohio, about 2:30 p. m., April 4. Many buildings were unroofed, several houses destroyed, and 12 persons seriously injured by the storm. The damage to property is estimated at between $50,000 and $100,000.

In the afternoon of April 5 a severe thunderstorm passed over Central City, Ky., wrecking several houses and otherwise doing considerable damage. This storm also had tornadic characteristics.

During the 15th and 16th severe thunderstorms, attended by destructive wind squalls and lightning, were quite general over the western portions of Kentucky and Tennessee. These storms were accompanied in several localities by unusually heavy hail, being very destructive to crops and window glass. The heavy downpours of rain, which also attended these storms, caused floods in the small rivers and local streams, resulting in many washouts. Railroads, highways, and crops suffered extensive damage.

April 15, during a heavy thunderstorm, 2 barns were struck and destroyed by lightning, 1 child was killed, and 2 adults badly stunned in Jackson County, Ala. April 16, during a heavy electric storm, 3 valuable thoroughbred horses were killed at Churchill Downs, near Louisville, Ky. April 23 a severe wind and rain storm did considerable damage at Gallatin, Tenn.

Forest fires raged during the early part of the month—until extinguished by rains—in eastern and south-central Kentucky and portions of western Pennsylvania. In Blount and Sevier counties, Tenn., 30,000 acres of timber land were burnt over and every vestige of living vegetation destroyed, entailing a loss of $100,000 and 2 lives.

During the latter part of March and the first week of April the bank of the Mississippi River between Wickliff and Fort Jefferson Landing, Ky., caved in to such an extent that the river now runs at the foot of a hill that formerly was half a mile from the east bank of the river.

(Continued from March Review.)

THE WORK OF THE WATER RESOURCES BRANCH OF THE UNITED STATES GEOLOGICAL SURVEY IN THE OHIO RIVER VALLEY.

By A. H. HORTON, Engineer, U. S. Geological Survey.

In June, 1908, the Water Resources Branch of the United States Geological Survey established an office at Newport, Ky. Newport is directly across the river from Cincinnati, Ohio. The office is located on the second floor of the Newport post-office.

This office was established for the purpose of studying the flow of the Ohio River and its tributaries, especial attention being given to the main tributaries and, as far as funds would allow, to study the flow of the main Ohio. It is the intention to make intense studies covering a period of 5 to 10 years of all the important tributaries, with the idea that when these studies are concluded the entire drainage basin of the Ohio River will be covered and there will be no stream of any importance but that there will be data available with reference to its flow, or information at hand whereby its flow can be determined with sufficient accuracy for all practical purposes in case no data have been obtained on that particular stream. At the end of the period of 5 to 10 years it is expected that enough data will have been obtained so that a majority of the gaging stations can be discontinued and other sections of the country will be covered in the same way. Ultimately the whole United States, or at least that part outside the arid or semiarid region will be thoroughly covered with run-off data.

From a comparison of a few long-time records of run-off of eastern streams, which are available, it has been found that the mean annual run-off for a single year may vary as much as 50 per cent from a 20 to 30 year mean; that the mean of a 5-year period may vary by 20 per cent; and that the mean of a 10-year period varies less than 10 per cent from the 20 or 30 year mean; that also during a 10-year period there occurs a year of average high and low water. While this low and high water may not be the extreme, it gives, nevertheless, the mean conditions which may be expected, with the exception of the abnormal year which generally occurs once or twice in a generation and is a matter of record or tradition in the locality in which it occurs. It is believed, therefore, that a record of the run-off of any eastern stream, extending over 10 years, will give a fair idea of the flow that may be expected at any time.

With this idea in view some 25 stations were established in the drainage basin of the New and Kanawha rivers in 1908, and are being maintained at present. It is expected that before the end of the 10-year period it will be found that many of these stations can be discontinued, for it is thought that studies of the data will show that it will be possible, by maintaining a few stations on the main river and on the more important tributaries, to obtain the run-off of any stream with sufficient accuracy from that actually measured at a few selected stations in the same drainage basin.

At the present time gage heights extending over a period of a year and a half have been obtained at these stations and a number of measurements have been made at medium and low water stages; measurements of high water will be obtained this coming spring. As soon as time and funds allow other tributaries will be taken up and studied in a similar manner until the entire basin of the Ohio is covered. Besides the work on the Kanawha River, stations are maintained on the tributaries that form the Monongahela and stations are maintained in cooperation with the United States Weather Bureau on the Muskingum, Great Miami, Wabash, and East Branch of White rivers.

Measurements of the Ohio have been made at Wheeling, Marietta, Cincinnati, Evansville, and Louisville, enough measurements having been made at Wheeling, Marietta, and Cincinnati to construct discharge curves for the Ohio at these points; at the other places only 1 or 2 measurements were made.

Measurements of the Ohio at Cincinnati were made at gage heights of about 3 feet and 54 feet; the record low water and high water stages are about 2 feet and 71 feet, respectively. The minimum flow is about 5,000 cubic feet per second; the maximum is, approximately, 700,000 cubic feet per second.

The State of Illinois, in cooperation with the United States Geological Survey, has had established and is maintaining about 20 gaging stations in that State. The State pays for all the field work and part of the computations, the work being done under the supervision of the Newport office. The work has been carried on for about 2 years and much valuable information has been collected which will be of use in land reclaiming, flood protection, and storage.

The United States Weather Bureau, in connection with extensive studies of evaporation being made at the Salton Sea in southern California, has established, with the cooperation of the United States Geological Survey, evaporation stations at various places in the United States. One of these stations is located

at the Cincinnati Water Works at California, Ohio. The apparatus was designed and installed under the direction of the Newport office. The evaporation from 2 pans, 1 floating on the surface of the reservoir and the other resting on a platform 10 feet above the reservoir, has been measured every 4 hours during the past season. These measurements were made under the direction of J. W. Ellms, superintendent of the filter plant. From the data collected at Salton Sea and at other points in the United States the Weather Bureau expects to obtain a comparatively simple formula with but few factors for deriving the evaporation from a body of water anywhere.

In addition to the work being done in the basin of the Ohio under the Newport office, run-off data on the Tennessee River are being obtained under the Atlanta office, and data are being collected on the Allegheny River, under the direction of the Albany office.

Besides the above work which is being carried on now, data have been collected during recent years on quite a number of other streams tributary to the Ohio. These data may be consulted in the published reports.

There are various uses to which run-off data may be put. One of the best illustrations of the direct economical value of this work is the water-power development in the Southern States. In this section, prior to starting the work of the Water Resources Branch, it was impossible to interest capital in water-power schemes, owing to the general impression that southern streams went dry in summer and flooded everything in spring. Based upon the data furnished by the Geological Survey, there are now going on in all parts of the south extensive power developments that will soon make that section a great manufacturing center that will rival New England.

The Austin (Tex.) Dam failed financially before the structure itself was destroyed because there were no data available in regard to the low water flow of the stream on which it was located; the loss entailed equaled the amount spent by the survey on stream gaging work during the first 10 years.

The most striking illustration of the value of stream gaging data is furnished by the Reclamation Service which is turning millions of acres of valueless land into farm land, worth in some cases over $1,000 per acre. The rapidity with which this Service was organized and results obtained were due directly to the available data in regard to stream flow which had been collected by the Water Resources Branch of the Geological Survey.

In the Ohio River Valley stream gaging data are of use in studying water supply and pollution problems; water-power investigations, drainage studies, and flood protection. During the summer and fall of 1908 many towns in the Ohio Valley were almost without water for drinking purposes. The population, and therefore the demand for water, is increasing all the time; in many cases the only way of providing water to last over periods of drought is to build reservoirs to hold the flood water that benefits no one and damages many. The only way reservoirs can be built economically is by knowing the necessary capacity which is determined by the available supply during dry spells in the streams from which the supply is taken. Records of the flow are of especial value in cases of this nature and the longer the record the greater the probability of the period of minimum flow being covered.

Water power is a subject of considerable importance in the Ohio Valley. With the continued advance in the improvement in the electrical transmission of power there will be no power site too far from the centers of industry to prevent its economical development. Our supply of coal is being rapidly depleted and the time is approaching when the development of the water power of the country will be an economic necessity. The Ohio Valley is particularly fortunate in having abundant supplies of natural fuel; it is equally fortunate in being supplied with abundant water power. It has been estimated that there is a minimum of 335,000 horsepower in the drainage basin of the Kanawha River alone, and on the Tennessee River above Riverton, Ala., there is a minimum of nearly 1,000,000 horsepower; these two examples indicate what may be expected from the other tributaries. Inasmuch as the amount of water power that may be made available is directly dependent on the flow of the streams, the investigation of the flow becomes a prerequisite in the economical development of water power and long-time records are especially valuable.

Navigation is also a subject of considerable importance in the Ohio Valley. The Federal Government is planning to spend, and has already spent, large sums upon the construction of locks and dams in the Ohio River. It is obvious that the determination of the stream flow is necessary to the intelligent solution of the many problems involved.

The damage from floods in the United States exceeds $100,000,000 annually, and in the year 1908 the aggregate damage, based on reliable data, approximated $250,000,000; a great part of this loss occurs in the Ohio Valley, and a still greater part may be attributed to the flood waters of the Ohio River, for they are a large factor in causing the floods on the lower Mississippi.

Probably the most important use of the stream gaging data collected by the Water Resources Branch of the Geological Survey in the Ohio River Valley is to furnish the data upon which to base studies and plans for controlling the floods of that river.

When run-off data covering the entire basin of the Ohio have been collected there will be available information from which plans and estimates can be made which will indicate beyond any doubt the feasibility of constructing a reservoir system on the tributaries of the Ohio River for controlling the floods. If the data verify and strengthen the claim that it is possible to reduce the heights of extreme floods from 10 to 20 feet by means of reservoirs, the cost of constructing such a system would seem to be a subject of minor consideration. For it would appear, if it were known beyond a reasonable doubt that floods on the Ohio River would not rise above a certain stage, that the increase in the value of the land along the Ohio River for manufacturing sites alone would pay for the cost of such a system of reservoirs. Assuming that manufacturing interests along the Ohio River and its tributaries increase during the next 50 years as they have in the past 50 years, who can predict the loss that would result from a flood similar to the 1884 flood 50 years from now? It is hardly probable that 50 years from now the floods of the Ohio River will still be the menace to manufacturing, agricultural, and navigation interests that they are to-day.

The data being collected by the Water Resources Branch of the United States Geological Survey will undoubtedly form the basis of any feasible scheme whereby the floods of the Ohio River will be deprived of their power of doing harm.